Strategic and Natural Risk in Entrepreneurship: An Experimental Study

by John Morgan, Henrik Orzen, Martin Sefton, and Dana Sisak

Abstract

We report on the results of experiments where participants choose between entrepreneurship and an outside option. Entrepreneurs enter a market and then make investment decisions to capture value. Payoffs depend on both strategic risk (i.e. the investments of other entrepreneurs) and natural risk (i.e. luck). Absent natural risk, participants endogenously sort themselves into entrepreneurial types and safe types and both types earn the same expected payoff. Adding natural risk fundamentally changes these conclusions: Here we observe excessive entry and excessive investment so that entrepreneurs earn systematically less than the outside option. These payoff differences persist even after many repetitions of the task. When the outside option becomes risky, we observe a "democratization" of entrepreneurship—the average individual enters and exits several times over the course of the experiment. Exit is hastened by unlucky outcomes: When realized payoffs fall below expected payoffs, subjects are more likely to exit the market. On the other hand, skill at the investment task plays little role in determining the likelihood of entrepreneurship. Finally, we examine an environment where an individual must become an entrepreneur but chooses the stakes over which she will compete. Here, we observe under-entry and under-investment in the high-stakes market, while the opposite is true in the low stakes setting. As a result, returns to entrepreneurship are positive under high stakes and negative under low stakes, even after subjects have considerable experience at the task.

Keywords: Entrepreneurship; entry; investment; experiment; risk

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1. Introduction

Entrepreneurship is widely viewed as a fundamental driver of economic growth. Many countries subsidize entrepreneurship, especially small-scale entrepreneurship. An important determinant of entrepreneurial activity and performance are risks of various forms. Much of the literature on entrepreneurship focuses on identifying characteristics and personality traits of would-be entrepreneurs.[1] Wu and Knott (2006) point out that, while entrepreneurs are conventionally risk-averse in responding to demand uncertainty, they are risk-seeking (overconfident) about risks related to their own ability. Along similar lines, we make a conceptual distinction between two aspects of risk: The first, which we term strategic risk, is the risk associated with the fact that payoffs are affected by the actions of other entrepreneurs and success or failure depends not only on one's own entrepreneurial decisions, but also on the entrepreneurial decisions of others. It is more difficult to succeed, and entrepreneurial returns are likely to be lower, in crowded markets where competitors invest heavily. The second type of risk, which we term natural risk, recognizes that entrepreneurial decisions alone do not determine financial outcomes. Luck also plays a crucial role. Certainly, any aspiring entrepreneur opening up a new restaurant or coffee shop realizes the role that fads, fashions, and other vicissitudes of fortune have on outcomes. In this paper we study the impact of these different types of risk on entry into entrepreneurship and subsequent performance.

Controlling for differences in strategic versus natural risk as well as the levels and riskiness of a would-be entrepreneur's outside option is often difficult using field data. Thus, we use laboratory experiments to examine how these factors influence entrepreneurship. The laboratory setting has the advantage that we can control for these aspects of the market precisely. This allows us to examine exactly how payoffs develop over time as well as between entrepreneurship and the outside option. We can also examine the life-cycle of entrepreneurship decisions, i.e. we can see how experience affects both entry and investment in entrepreneurial activity.

As far as we are aware, our study is one of the first to investigate different types of entrepreneurial risks using the methodology of laboratory experiments.[2] Previous experiments have examined isolated aspects of the entrepreneur's choice. For example there is an extant experimental literature on the decision to enter the market in the first place. In the standard entry experiment, individuals simultaneously decide whether or not to enter and payoffs are determined according to a schedule such that entry payoffs are decreasing in the number of entrants. Equilibrium, which is typically in mixed strategies, suggests that entry will occur up to the point where the expected profits of each entrant are equal to the value of the outside option. The main finding in this literature is that theory models of entry perform extremely well in characterizing behavior. Indeed, Nobel Laureate Daniel Kahneman famously quipped that theory worked like "magic" in predicting behavior in these games. Subsequent studies have found slight tendencies toward excess entry when equilibrium predicts few entrants and under-entry when

[1] See, for example, Parker (2009) who offers a survey as well as Caliendo and Kritikos (2012) for an overview of recent developments in this literature.

[2] The only other work of which we are aware is Camerer and Lovallo (1999). See Bohnet et al. (2008), as well as Eckel and Wilson (2004), for comparisons of strategic and natural risk in trust settings.

equilibrium predicts many entrants (see Camerer, 2003, for a review). Even so, the fundamental prediction of competitive equilibrium—payoff equalization of entrants relative to the second best alternative—continues to acquit itself nicely.

The central contribution of our paper is to study entry decisions in contexts that more closely mimic those faced by entrepreneurs. Specifically, we modify the standard entry game as follows: Subjects make real-time entry decisions where they observe the number of entrants currently in the market. In our view, this is a closer match to the reality of entry than the usual model where entry decisions are made simultaneously and where the key difficulty is to overcome the coordination problem. Following the entry decision, entrants participate in a Tullock (lottery) contest in which they simultaneously make investments in their businesses.[3] Larger relative investments produce a greater expected share of the profits in the industry; however success is by no means guaranteed. In some treatments, luck plays a key role—here a single winner is determined where the probability of winning is proportional to the relative investments made. In other treatments, the link between payoffs and investment is more direct. Each entrant enjoys a fraction of industry profits in proportion to their investments.

We also vary the nature of the outside option. In our baseline treatment, the outside option is deterministic. But in practice the alternative to not entering a market may be inherently risky. Indeed, often the second best use of an entrepreneur's time and talent is undertaking another, different startup. To capture these differences, we conduct treatments where the payoff from the outside option is stochastic and where the outside option represents an alternative entrepreneurial opportunity.

Together, our treatments shed light on the role of strategic versus natural risk on entry decisions and post-entry performance. They also allow for a more nuanced view of the fundamental prediction of competitive equilibrium—the equalization of the value of inside and outside options—when outside options have both environmental and strategic risk as well. Our experiments are designed to come closer in bridging the gap between the simple and elegant theory of equilibrium entry with the messy reality of real world entry decisions.

We begin by reproducing the results from standard entry experiments. Consistent with earlier studies, we observe payoff equalization between entrepreneurship and the fixed outside option in a setting where "entrepreneurship" merely amounts to entering a market and where each entrepreneur earns a fixed payoff which is declining in the number of entrants. Moreover, specialization naturally arises: some individuals repeatedly choose the entrepreneurship path while others follow a different path and select the outside option.

With that background in mind, our main findings are as follows:

1. The addition of strategic uncertainty alone does not alter these conclusions. While initially, there is some excess entry and overly aggressive investments post-entry, this behavior moderates with experience and leads to results in line with theory predictions. There is a strong sorting of individuals into entrepreneurial and non-entrepreneurial types over time.
2. When both strategic and natural risks are present, the results change considerably. It is no longer the case that the expected payoffs from entrepreneurship equalize with the outside

[3] See Tullock (1980).

option. Instead, entrepreneurs earn persistently *lower* returns than those choosing the outside option. When would-be entrepreneurs are relatively inexperienced, there is both excess entry and excess investment into the entrepreneurial activity, which results in very poor outcomes compared to the outside option. With experience, there are fewer would-be entrepreneurs as entry and investment rates decline. However, entry rates remain excessive and post-entry behavior is still characterized by excess investment; hence entrepreneurial returns remain poor compared to the fixed outside option.

3. The addition of natural risk "democratizes" the prospects of being an entrepreneur. It is no longer the case, even with experience, that individuals are strongly divided between entrepreneurs and those choosing the outside option. Instead, there is constant churn as subjects enter and exit the entrepreneurial role over time.
4. Adding natural risk to the outside option increases entry into the entrepreneurial activity but reduces average post entry investments relative to the theory benchmark. This shift can be explained in part by the nature of the return structure of entrepreneurship in the model. By choosing to be an entrepreneur while making no post-entry investment, an individual can avoid exposure to random payoffs. This choice comes at a cost however, as the would-be entrepreneur has little chance of success in the market and gives up the positive returns from the outside option in exchange for this "safe harbor."
5. Adding both environmental and strategic risk to the outside option leads to the largest payoff differential. In this treatment, subjects are presented with a choice of two entrepreneurial opportunities, one with a large prize for success while the other with a more modest prize. Here we find excess entry and investment in the activity with the modest prize and too little entry and investment for the activity with the large prize. These differences remain even after 50 iterations of this set of choices.

Our findings 1 and 2 also shed light on the experimental literature on contests.[4] The main finding in this literature is that there is excess investment in these contests when competitors are exogenously chosen. We allow for endogenous selection as well as varying the payoff structure on the contest. A key finding is that, by eliminating natural risk from the contest, overinvestment moderates significantly and indeed, payoffs are close to equilibrium predictions. This latter result is at odds with Cason, *et al.* (2010). In a real effort experiment, they compare entry and performance in a number adding task where the outside option consists of piece rate payments and the inside option is either a shares or winner-take-all contest. They find that the shares (proportional prize) contest leads to greater entry but no difference in individual performance (the analog to investments in our setting) relative to a winner-take-all scheme. They suggest that differential entry is the result of skill differences among individuals. Only high skilled individuals compete in the winner-take-all contest whereas the shares contest attracts lower skilled players. In our setting, all individuals have the same capabilities and costs to invest, thus skill differences are less pronounced.

Our finding 5 relates to Mazzeo (2004) and Nguyen-Chyung (2011) who highlight how changes in natural risk affect decisions about the type of entrepreneurship to pursue. In particular, we find

[4] See for example Millner and Pratt (1989, 1991), Shogren and Baik (1991), Davis and Reilly (1998), Anderson and Stafford (2003), Potters, de Vries and van Winden (1995), Fonseca (2009), Herrmann and Orzen (2008) or Morgan, Orzen and Sefton (2011).

that when the stakes from winning the market increase (i.e. entrepreneurship becomes riskier), individuals scale back their entry and investment choices.

In certain respects, the behavior of our entrepreneurs is puzzling: Even after considerable experience, the basic prediction of competitive equilibrium, the equalization of payoffs between the inside and outside option, fails to hold. Interestingly, our results are consistent with the seminal paper of Hamilton (2000) who attributes the negative returns to entrepreneurship to non-pecuniary benefits from entrepreneurship. Our findings suggest other forces are at work as well: non-pecuniary benefits are quite limited in our laboratory setting, yet payoff differences are still large and persistent. In section 6, we explore a number of plausible amendments to the standard model, including differing risk preferences, non-pecuniary motives, and loss aversion. We show that none of these is sufficient to rationalize the constellation of findings we observe.

Regardless of the theoretical rationale, our results offer both a useful bridge toward seeing how the structure of strategic and natural risk affect investment decisions as well as explaining key factors that lead individuals to pursue entrepreneurship. They also present an important challenge to existing theory.

The remainder of the paper proceeds as follows. Section 2 describes the experiment as well as the rationale for each of the treatments and provides theoretical benchmarks. In section 3, we present the results of the experiments in terms of entry and investment decisions. We pay particular attention to the dynamics of these choices—as we will see, experience plays a key role. In section 4, we examine key factors leading to the entrepreneurship path. These include having good luck in past ventures, skill at the task, as well as demographic characteristics. Owing to the failure of the payoff equalization hypothesis from competitive equilibrium, in section 5, we consider various amendments to the theory that attempt to better match our findings. All of these explanations prove extremely limited. Finally, section 6 concludes.

2. Experimental design, procedures and predictions

The experiment was conducted in multiple sessions at the University of Nottingham. Subjects were recruited from a campus-wide distribution list of undergraduates, and no subject appeared in more than one session.

At the beginning of each session, subjects were seated at computer terminals and given a set of instructions which were read aloud.[5] Any questions were dealt with in private by a monitor. No communication between subjects was permitted, and all choices and information were transmitted via the computer network. Before the decision-making part of the experiment began, groups of six subjects were randomly formed and these remained fixed for the entire session. Subjects knew this but did not know which of the other people in the room were in their group. The decision-making part of the session then consisted of fifty rounds in which subjects could earn points. At the end of the session, one of the 50 rounds was chosen at random and subjects were paid in cash according to their point earnings from this selected round. An exchange rate of £0.10 per point was applied. Sessions took between 50 and 75 minutes and earnings ranged

[5] See Appendix A for the instructions used in the experiment.

between zero and £28.50, averaging £10.81 (approximately US$20 at the time of the experiment).

In each round, a subject was given 100 points and had to choose between two options, labeled "A" and "B", where "A" corresponds to the outside option and "B" corresponds to the decision to become an entrepreneur. A timer was displayed on the subjects' screens, counting down 15 seconds. Subjects were informed that if they did not make a choice within the time limit the computer would make a choice for them at random.[6] During this time they could see how many members of their group had chosen each option and how many had not yet chosen. Once a subject had chosen either option A or B, he or she could not reverse that decision. The information on other group members' decisions was anonymous, in the sense that subjects could only see the number in each category and could not track who of the other group members were in each category from round to round. We incorporated this design choice to minimize the ability of subjects to build reputations.

The consequences from choosing A or B varied across our experimental treatments to reflect entrepreneurship decisions with different types of risk and different outside options. In each case the relevant consequences were carefully explained to subjects in a neutral language at the beginning of the session.

Our *Baseline* treatment largely represents a replication of earlier laboratory experiments on entry where no post-entry decisions have to be taken and each entrant receives a fixed payoff decreasing in the number of entrants. In this treatment the outside option was worth 10 points while each entrepreneur simply earned $50/n^2$ points (for simplicity we rounded the relevant amounts to integers). Thus, if only one entrepreneur entered, that person received 50 points. If two entrepreneurs entered, each of them earned 13 points. With three entrepreneurs each received 6 points, and so on (the analogous amounts for four, five and six entrants were 3, 2 and 1 points). After each round everyone observes the payoffs of all group members.

Relative to earlier entry experiments the main variation in our Baseline treatment is in the timing of moves. While the extant literature has subjects move simultaneously, we allow subjects to enter in real time and observe the number of entrants up to that point.

What does theory predict for an entry game in continuous time? Assume that the players are all rational payoff maximizers. A player can choose some point in time t over a continuous time interval $[0, T]$ to select either entrepreneurship or the outside option. At each point in time, the choices made by all other agents are publicly observable. The earliest point at which a player can take a decision is determined by her reaction time. Suppose that the reaction time r_i of player i is private information and consists of a draw from a uniform distribution having support on $[0, \varepsilon]$, where ε is arbitrarily small and publicly known. Define n^* to be the largest integer n such that $\pi(n) \geq \pi_0$ where π_0 is the expected value of the outside option (in our Baseline treatment $\pi_0 = 10$ and $n^* = 2$). For generic parameter values, $\pi(n^*) > \pi_0 > \pi(n^* + 1)$; thus, entrepreneurship yields a strictly higher expected return than the outside option (in our Baseline treatment $\pi(n^*) = 13$). As a consequence, all players will choose to enter at the earliest possible

[6] Once the timer had counted down from 15, the computer displayed '0' for one second before it made the random choice. Thus, the effective time limit for subjects was in fact 16 seconds. About 2.5% of decisions were made by the computer. Our results are unaffected by the inclusion or exclusion of this data.

moment so long as the number of existing entrants is $n^* - 1$ or lower. Thus, if we order the agents from lowest to highest reaction times, then every agent $i \leq n^*$ will enter at time r_i while the remaining agents will choose not to become entrepreneurs.

In our *Shares* treatment, the outside option again yielded 10 points. In contrast, entrepreneurs were paid according to their investment decisions. These investments decisions were made simultaneously, after the entry phase and knowing the number of entrepreneurs in the market. An entrepreneur i investing x_i (taken from her initial endowment) earned a share $x_i/\sum x_j$ of a 50 point prize (rounded to integers). At the end of each round, all subjects in the group, entrepreneurs or not, were informed about all payoffs, the investments of each entrepreneur and also reminded of the fixed outside option.

The entrepreneurship subgame with n entrepreneurs has a unique symmetric equilibrium characterized by an investment of

$$x^*(n) = \frac{50(n-1)}{n^2}.$$

Given this equilibrium investment behavior, the expected profits from entrepreneurship when there are n entrants is $\pi^*(n) = 50/n^2$—the same as in the *Baseline* treatment. Consequently, there is no predicted difference in the entry phases of the *Shares* and *Baseline* treatments. Two entrepreneurs should enter and then earn 13 points each.

In the *Winner-Take-All* treatment entrepreneurs faced natural risk as well. That is, instead of receiving a fraction of the prize, only a single entrepreneur was successful and received the entire 50 points. The probability of winning depended on the relative investments and was, in fact, $x_i/\sum x_j$. To determine the winner a computerized animated lottery wheel was used (publicly). If exactly one entrepreneur chose to enter, that person received the prize automatically without having to invest. Non-entrepreneurs receive a fixed pay of 10 points as before. Again, everyone received feedback after each round on the decisions of the others and the payoffs.

The equilibrium predictions do not change whether $x_i/\sum x_j$ is entrepreneur i's share of the prize or her chance of winning the prize. Of course, this relies on risk neutrality. If agents are risk averse, then natural risk will play some role. In particular, the addition of natural risk should increase the expected returns to entrepreneurship relative to the outside option. The theoretical predictions also rely on the assumption that agents are identical. The presence of heterogeneities in the preferences of agents will create a sorting role for entrepreneurship independent of reaction time.

Our *Coin Flip* treatment introduces natural risk to the outside option. In this treatment, the outside option involved a lottery in which the subject, with a 50-50 chance, either won 35 points in addition to the initial endowment or lost 15 points. The outcome of this lottery was determined and visualized with a computerized coin toss. In all other respects the *Coin Flip* and the *Winner-Take-All* treatments were identical. Also as in the other treatments, all subjects observed both the payoffs of the entrepreneurs and non-entrepreneurs (in this case: either +35 or –15). We picked the two coin-flip outcomes in such a way that the expected value was 10 points, the value of the outside option in the *Winner-Take-All* treatment, and that the variance of the coin-flip payoffs was identical to the variance of payoffs in the contest option under equilibrium play (two entrants who each invest a quarter of the prize). Again, under the assumption that agents are identical risk-neutral payoff maximizers there is no predicted difference between this and the other treatments.

Finally, in the *Dual Market* treatment the outside option was *another contest*. Option B remained as in the *Winner-Take-All* treatment, and the only difference between options A and B in the *Dual Market* treatment was that the value of the option A prize was 200 points. This represents a situation where the outside option of an entrepreneur is to become an entrepreneur in a different, higher stakes, market. Suppose the symmetric equilibrium is played in both subgames. If n entrepreneurs choose the 50-point contest their expected payoff is $50/n^2$ points each, while the expected payoff for the remaining $6-n$ entrepreneurs in the 200-point contest is $200/(6-n)^2$ points. The expected payoffs are equalized, and equal to 12.5, when $n=2$. With two entrepreneurs in the 50-point contest and four in the 200-point contest switching to the other contest would leave any entrepreneur worse off. Under any other distribution of entrepreneurs between the two contests, however, switching is always payoff-improving for individuals in one of the two groups.

Altogether 270 subjects participated in the experiment, 54 in each of the five treatments. We ran a total of 15 sessions, three in each treatment, 18 subjects per session. Each session was comprised of three groups of six subjects, yielding a total of 9 statistically independent observations per treatment.[7] Table 1 summarizes experimental design.

Table 1. Experimental treatments

Treatment	Outside option ('Option A')	Entrepreneurship option ('Option B')	Equilibrium number of entrepreneurs	Experimental groups
Baseline	10 points	Fixed payments declining in the number of entrepreneurs	2	9
Shares	10 points	50-point proportional-shares contest	2	9
Winner-Take-All	10 points	50-point winner-take-all contest	2	9
Coin Flip	50-50 chance of +35 or –15 points	50-point winner-take-all contest	2	9
Dual Market	200-point winner-take-all contest	50-point winner-take-all contest	2	9

3. Results

We begin by presenting the results from our simplest treatment, *Baseline*, which replicates existing studies. We then proceed to the results from our other treatments, in which entrepreneurs compete with one another after entering, to show how enriching the post-entry decision environment with strategic and natural risk affects entry and equilibration.

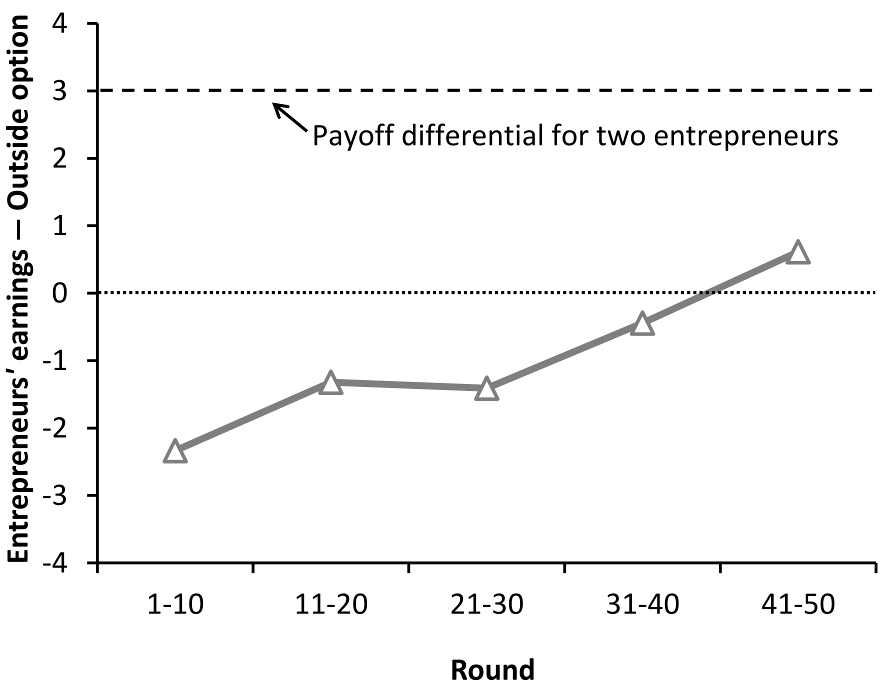
[7] In one of our *Dual Market* sessions a technical problem resulted in our losing the last three rounds of data from one group and the last two rounds of data from the other two groups.

3.1 The *Baseline* treatment

The main prediction for the *Baseline* treatment is that subjects becoming entrepreneurs should earn slightly higher profits than those remaining on the sidelines and, this being the case, subjects should rush into entrepreneurship at first opportunity.

Figure 1 displays the average difference between the payoffs from entering and the outside option over the course of the experiment, in blocks of ten rounds. While the sharp prediction that entrepreneurs earn more than non-entrepreneurs is not borne out, the weaker form of the competitive equilibrium hypothesis, that there should be little difference in payoffs between the two options, is supported, at least in later rounds of the experiment.[8]

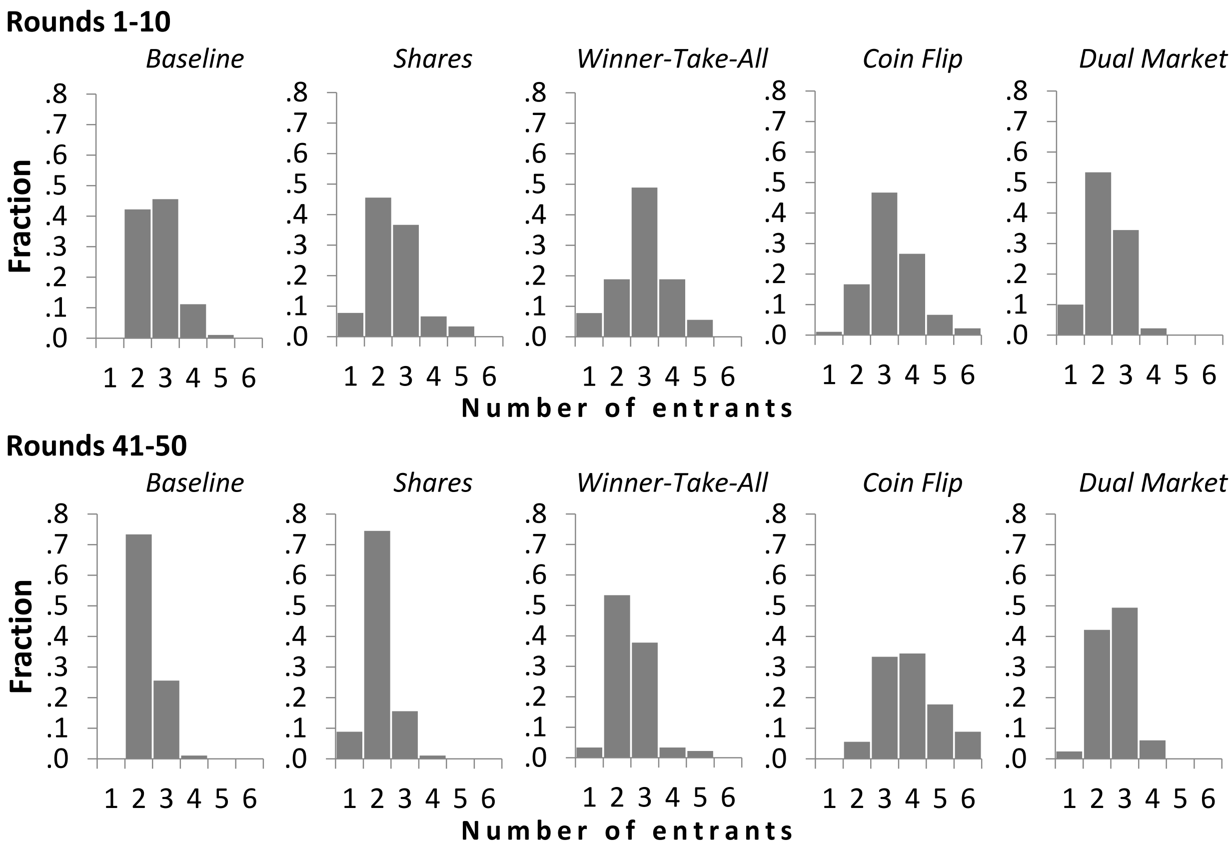
Figure 1. Payoff differentials in the *Baseline* treatment



In this treatment, payoffs to entrepreneurship purely depend on the number of entrants—post-entry decision making is absent. This eliminates both natural and strategic risk as a post-entry consideration. Moreover, since entry occurs in continuous time, strategic risk is quite limited in the overall game as well. Recall that the equilibrium number of entrepreneurs is 2. As Figure 2 shows, entry rates in *Baseline* are often higher than that in the early rounds of the experiment. Towards the end, however, the typical outcome is indeed a market with two entrepreneurs.

[8] Focusing on rounds 1-10, we reject the null hypothesis of payoff equalization between inside and outside option (p=0.004) using a nonparametric two-sided one-sample Fisher-Pitman test based on the average payoff differentials from our nine independent experimental groups. For rounds 41-50 we no longer reject the payoff equalization hypothesis (p=0.332). Note that we will use the same test procedure throughout this section when we statistically compare observed behavior and theoretical benchmarks.

Figure 2. Distribution of entrants in early and late rounds



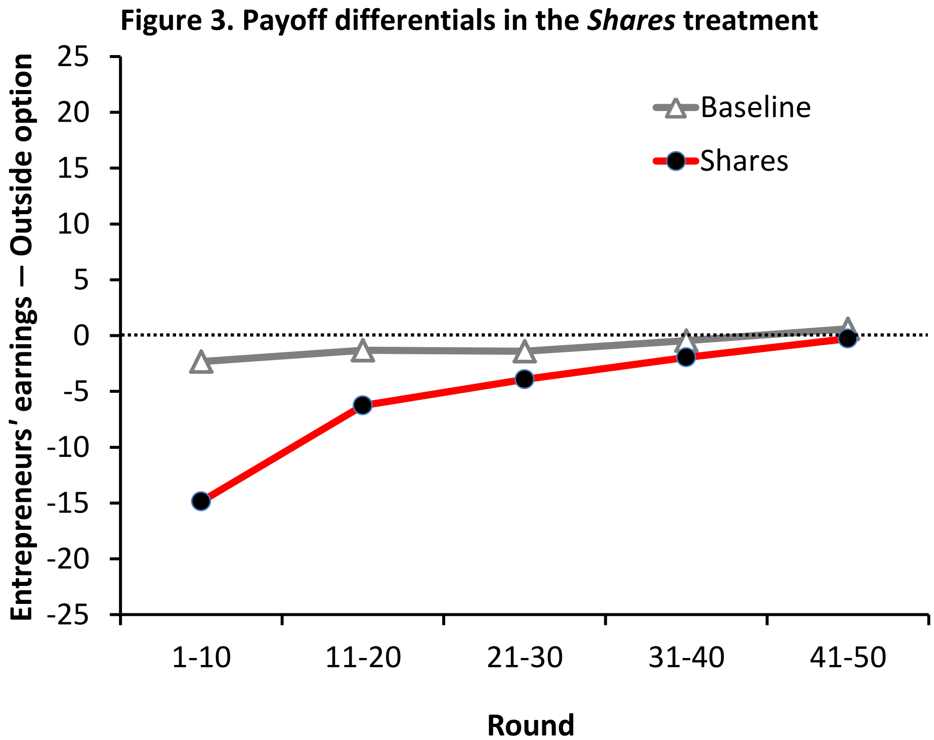
One novel prediction of our experimental design concerns the timing of entry—theory predicts that entry should occur quickly. Our results are consistent with this prediction. Across all *Baseline* entry games the median time of the first entrant was 0.37 seconds (0.31 seconds in the last ten rounds), and the median delay between the first and second entry was 0.3 seconds (0.25 seconds in the last ten rounds). As a result, entry games effectively ended quickly. Across all fifty rounds, the final number of entrants was determined within a second in 49% of all entry games. In 68% the final number was determined within the first two seconds. By the last ten rounds subjects had become even faster and 63% [86%] of games were completed after only one [two] second[s].

Our interpretation of these results is that subjects recognized the potential three-point advantage of being one of two entrants. Since all players have the same opportunity to enter, the identities of the entrants were determined by a race, which sometimes—mostly in early rounds—resulted in coordination failure such that more than two players entered. Thus, the entrepreneurial rents associated with two entrants were effectively competed away in this race, leaving the returns to entrepreneurship even closer to the outside option.

3.2 Strategic risk: The *Shares* treatment

Compared to *Baseline*, the *Shares* treatment adds post entry decision making and, consequently, strategic risk, to payoff calculations. There is, however, no random element to payoffs—an entrepreneur earns a fraction of the value of the market equivalent to her investment relative to the sum of investments of all entrepreneurs.

Figure 3 depicts the average payoff difference from pursuing entrepreneurship relative to the outside option over the course of the experiment. As a reference, we also include the payoff differential under the *Baseline* treatment, where strategic risk is absent. As the figure highlights, the introduction of strategic risk turns the payoffs from entrepreneurship sharply negative in the early rounds. With experience, the payoff differential narrows such that, by the end of the experiment, the returns to entrepreneurship are about the same as the outside option.[9]



In the *Shares* treatment the returns to entrepreneurship are determined by both the number of entrants and the degree of competition in the investment stage. As Figure 2 reveals, entry rates are similar to those in the *Baseline* treatment. Thus, the addition of strategic risk does not lead to wholesale changes in entry behavior. The more important factor explaining the low returns to entrepreneurship in the earlier rounds of the *Shares* treatment is investment behavior. Table 2 shows a measure of investment behavior for each treatment, averaged over all rounds and over early and late rounds separately. Normalized investment is defined as investment minus the prize per investor ($x - R/n$). This measure offers two useful benchmarks. First, when the normalized investment averaged across all entrants is positive, then entrepreneurs are investing amounts that, in total, exceed the value of the prize. In other words, there are negative returns to entrepreneurship. Second, when the normalized investment averaged across entrants is -10, then entrepreneurs earn the same expected return as the outside option. For future reference, when we refer to investment, we mean normalized investment.

[9] As in the *Baseline* treatment we reject the null hypothesis of payoff equalization between inside and outside option for rounds 1-10 (p=0.004) but fail to reject it for rounds 41-50 (p=0.832).

Table 2: Normalized investments (Investment – Prize/Entrants)*

Treatment	All rounds	Rounds 1-10	Rounds 41-50
Baseline	-	-	-
Shares	−4.1 (15.2)	5.0 (23.2)	−9.5 (10.9)
Winner-Take-All	−.4 (16.9)	11.2 (23.4)	−4.4 (11.4)
Coin Flip	−2.4 (13.2)	4.8 (20.9)	−4.6 (9.5)
Dual Market – Small	−3.1 (16.7)	5.8 (25.2)	−5.8 (10.7)
Dual Market – Large	−17.3 (30.6)	−11.4 (29.2)	−20.8 (31.8)

* The number in brackets is the standard deviation. Entries for the *Baseline* treatment are left blank since there is no investment activity for this treatment.

As Table 2 shows, normalized investments in *Shares* decline significantly over the course of the experiment. In rounds 1-10, total investments exceed the value of the market, so the returns to entrepreneurship are negative. Indeed, conditional on entering, a would-be entrepreneur is better off investing nothing rather than making the average investment. With experience, entrepreneurs become savvier investors. By rounds 41-50, investments are only slightly above the breakeven level. Thus, investments converge (from above) to breakeven levels.

To summarize, the additional complexity of strategic risk initially leads to poor returns from entrepreneurship. Returns are depressed owing mostly to overinvestment rather than excess entry on the part of entrepreneurs. However, as subjects gain experience, these differences are erased.

Our laboratory experiments are analogous to findings in the market for realtors. There are low barriers to entry in this business; thus one would expect payoffs to equalize between entrepreneurship and the outside option.[10] Moreover, success in this industry largely depends on the size of the market, the number of competitors, and the effort invested in pursuing leads. Strategic risk is present in that the returns from invested effort depend on the number of other realtors operating in the same geographic area and their level of effort investment. Jud and Winkler (1998), for example, show that the returns to entrepreneurship are similar to the other opportunities available to those pursuing this profession.

3.3 Natural risk: The *Winner-Take-All* treatment

Next, we examine how introducing environmental uncertainty into entrepreneurship affects entry and investment behavior of our entrepreneurs. In our *Winner-Take-All* treatment, the entrepreneurs again simultaneously choose investments. But now only one of the entrepreneurs is awarded a prize, with the winner being determined by a lottery in which each entrant's probability of winning equals his or her investment as a fraction of total investments. Under risk neutrality, the Nash equilibrium of this n-player contest results in the same expected payoff to an entrant as in the *Baseline* and *Shares* treatments.

[10] To become a salesperson requires passing a test. Becoming a broker is slightly more involved as it requires an individual to have a requisite amount of experience and pass an additional test. There are no formal education or other hurdles and pass rates on tests tend to be quite high.

Figure 4. Payoff differentials in the Winner-Take-All treatment

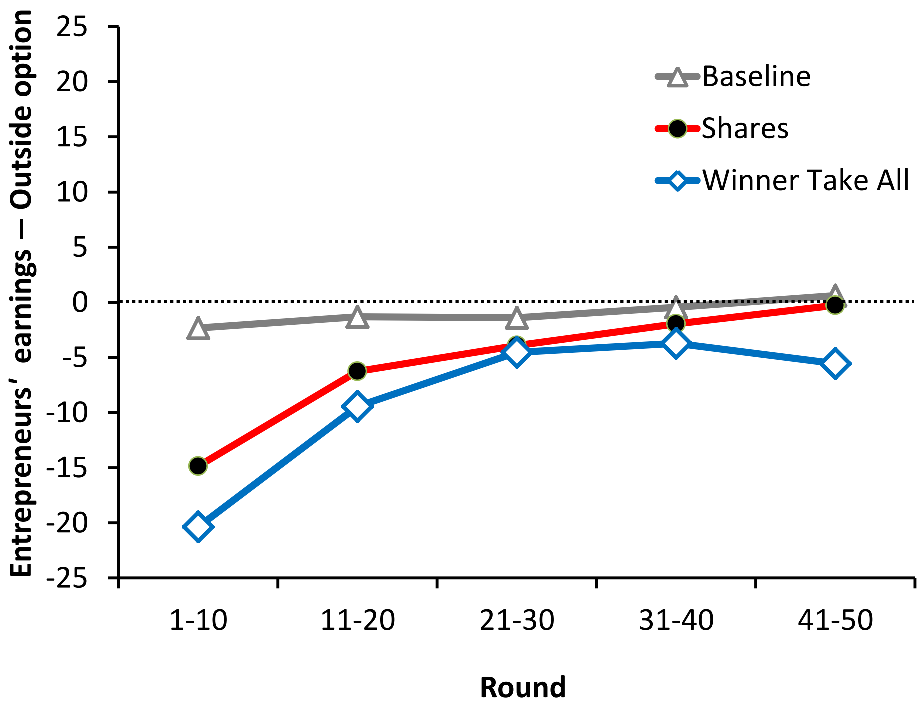


Figure 4 displays the average payoff differential under the *Winner-Take-All* scheme compared to *Baseline* and *Shares*. Initially, the returns to entrepreneurship are substantially negative. With experience, these returns improve but even in the later rounds of the experiment, the presence of both strategic and natural risk leads to payoffs from entrepreneurship that continue to lag those from the outside option. In other words, the prediction that entry and investing will occur up to the point where the payoffs from the two activities equalize is simply not supported by the data. The null hypothesis of payoff equalization between inside and outside option for rounds 41-50 is rejected in *Winner-Take-All* ($p = 0.051$).[11]

The poor returns from entrepreneurship are, in part, driven by excess entry. Returning to Figure 2, the median number of entrants is three initially and even in the last ten rounds of the experiment there are a substantial number of markets where more than two subjects enter the market. Entry in the *Winner-Take-All* setting systematically exceeds that of the setting without natural risk: in *Shares* the probability of observing more than two entrants in the last ten rounds is 0.167, while in *Winner-Take-All* it is 0.433. This difference is statistically significant (p-value = 0.031).[12]

It appears that natural risk makes the entrepreneurship path more enticing for subjects. Presumably, subjects are lured by the possibility of winning the entire market. What is more

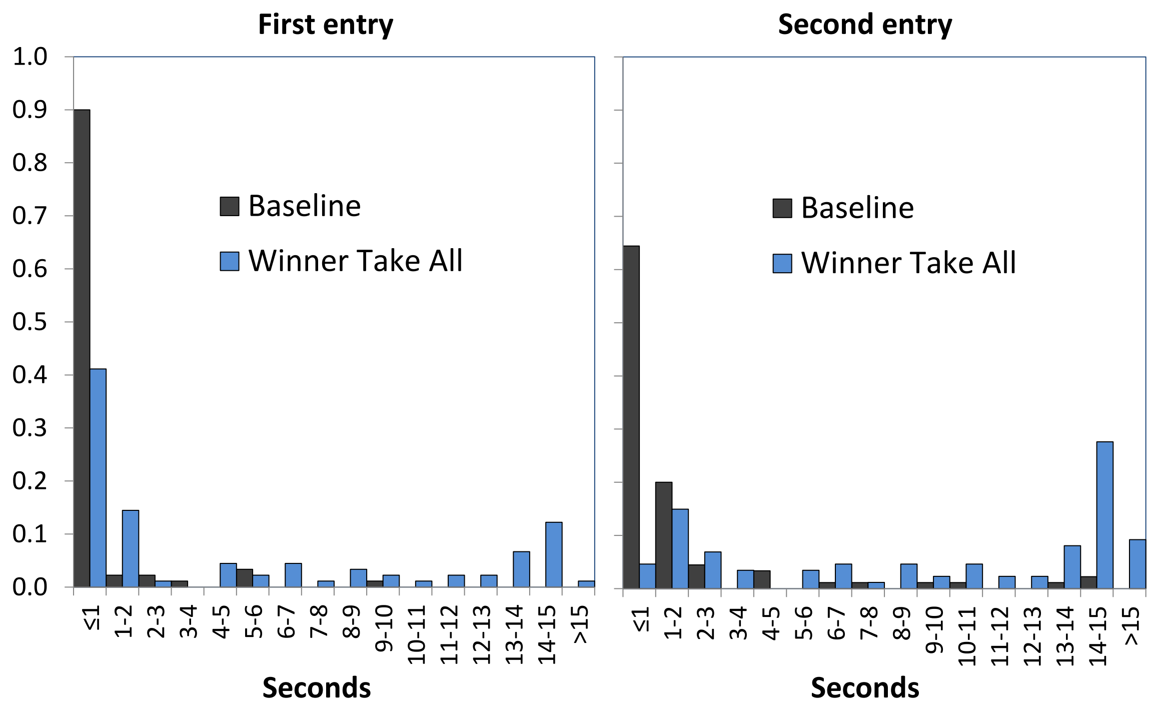
[11] Note that the returns from the outside option are more than twice as high as those from entrepreneurship in the last 10 rounds (and almost 8 times as high across all 50 rounds). The outside option is a significantly better investment. Moreover, it is risk free whereas the payoffs from entrepreneurship are highly variable. Thus, any risk-adjusted measure of returns will produce an even wider gap in favor of the outside option.

[12] This p-value stems from a nonparametric two-sided two-sample Fisher-Pitman test applied at the level of statistically independent groups. We will use this test again whenever we statistically compare observed behavior between two treatments.

surprising is that, despite the negative experience of, on average, losing money by choosing the entrepreneurship path, this lure remains potent even after subjects have considerable experience.

While under the *Baseline* treatment, subjects were anxious to become entrepreneurs at the earliest opportunity, the presence of natural risk leads subjects to pause before making the entrepreneurship "leap". Figure 5 displays the timing of the first entry compared to *Baseline*. Notice that there is, on average, a considerable delay before even the first subject decides to become an entrepreneur. Furthermore, the second entrant takes considerably longer to contemplate the strategic environment before committing to enter in the *Winner-Take-All* treatment. Thus, excess entry is not due to lemming-like herding on the part of subjects seeking to pile into what they might consider a good but perishable opportunity (entrepreneurship); rather would-be entrepreneurs seem to consider the pros and cons of entry before committing.

Figure 5. Histograms of first and second entry times (based on last ten rounds)



While the negative returns to entrepreneurship are partially due to excess entry, excess investment also plays an important role. As Table 2 highlights, there is extreme overinvestment in the early rounds and although entrepreneurs learn to moderate their investments towards the end of the experiment these amounts still exceed the breakeven threshold. Normalized investments in rounds 41-50 are also significantly higher in *Winner-Take-All* than in *Shares* (p-value = 0.046). Thus, the addition of natural risk to the entrepreneurship path clearly drives increased investment activity.

To summarize, the presence of natural risk creates an entrepreneurship "trap"—subjects are lured in by the prospect of securing the whole market. This leads to excess entry and excess investment, even after considerable experience with the game. In a sense, hope springs eternal for entrepreneurs seeking to win the market. As a result, the returns from entrepreneurship remain consistently below those of the outside option.

Our results for the *Winner-Take-All* treatment are reminiscent of the entrepreneurial decision to open a restaurant. It is well-known that most entrants into restauranteering result in failure (Bloomberg BusinessWeek, May 19, 2003). Moreover, natural risk plays a key role in the success or failure of a restaurant. Some restaurants strike it lucky and end up becoming “hot” places to eat while most restaurants struggle despite considerable investment and effort on the part of their owners. Indeed, casual empiricism suggests that hot restaurants are often not the best in terms of the quality of the food, ambiance, or service. Despite the high risk of failure, there is no shortage of new entrepreneurs entering the market each year, convinced that they have found the correct “recipe” of luck and skill to produce a positive outcome.

3.4 Introducing natural risk into the outside option: The *Coin Flip* treatment

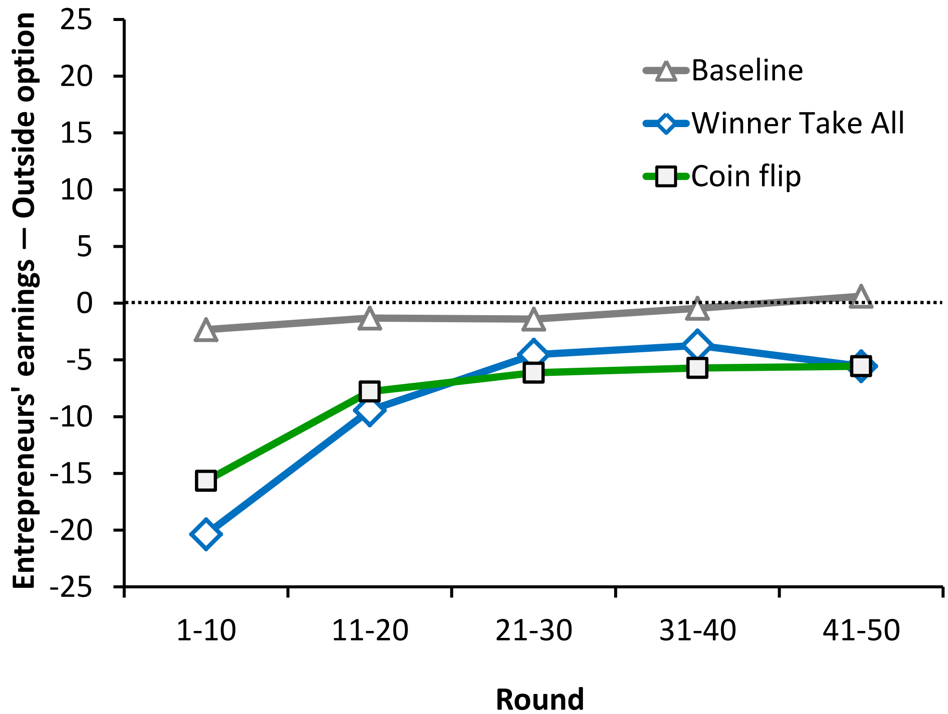
While we have modeled the outside option as fixed thus far, in reality alternatives to the entrepreneurship path offer their own set of risks and rewards. Often, these will be natural rather than strategic risks as the usual alternative to entrepreneurship is becoming a worker of some kind where investment and other strategic decisions occur at the firm level rather than the individual employee level. Our *Coin Flip* treatment investigates how entrepreneurship decisions change when then the outside option exhibits natural risk. Note also that if one wanted to rationalize our *Winner-Take-All* results by appealing to risk preferences, one should expect that the (expected) payoffs from the two activities be approximately equal in *Coin Flip* since the riskiness of the two activities is approximately equal.[13]

Figure 6 displays the average payoff differential under the two activities. For comparison, we include the payoff differential from the *Winner-Take-All* treatment; thus, the difference between the two represents the pure effect of adding natural risk to the outside option. As the figure shows, the payoff differentials in the two treatments are very similar. Initially, the risky outside option narrows the payoff differential slightly. However, over the course of the experiment the returns from entrepreneurship in *Coin Flip* and *Winner-Take-All* become nearly indistinguishable. Once again, the null hypothesis of payoff equalization is rejected (p-value = 0.004 based on rounds 41-50).

While on the surface there is hardly any change, the entrepreneurial decisions that drive the payoff differentials in *Coin Flip* are indeed very different from the decisions in the *Winner-Take-All* treatment. First, as shown in Figure 2, there is much more entry. The mean number of entrants in the last ten rounds of *Coin Flip* is 3.9 compared with 2.5 in the *Winner-Take-All* treatment. The difference is statistically significant (p-value < 0.001). Unlike in any of the previous treatments, entry increases over time, despite the persistently low returns from entrepreneurship.

[13] Recall that we calibrated the risk from the coin flip with the equilibrium risk from entrepreneurship. Furthermore, the average standard deviation of entrepreneurial earnings in the last ten rounds of *Winner-Take-All* (25.02 points) is almost identical to the standard deviation of coin flip earnings (25 points).

Figure 6. Payoff differentials in the *Coin Flip* treatment



Second, the introduction of natural risk to the outside option changes investment decisions. A substantial number of individuals enter the market and subsequently make very low investments.[14] In the *Coin Flip* data this occurs about 44% of the time while the corresponding figure in the *Winner-Take-All* treatment is only 15%. By adopting a strategy of entering and then bidding low, subjects can avoid natural risk but at the cost of forgoing the expected return from the outside option. In effect, this is a second, risk-free outside option and many subjects choose this option.

How does accounting for different motivations to enter affect our results? If, in both treatments, we count as entrepreneurs only those who enter and invest more than five tokens, the difference in the number of entrepreneurs between the *Coin Flip* and the *Winner-Take-All* treatments is no longer statistically significant (p-value = 0.309 based on rounds 41-50). Similarly, there is also no significant difference in the normalized investments observed in *Coin Flip* and *Winner-Take-All*.

To sum up, we find that a risky outside option increases entry while reducing investment. However, this is largely driven by individuals who seek to avoid risks and pursue a strategy of entering and investing little. Others behave very much like subjects in the *Winner-Take-All* treatment. In this respect our findings are closely related to Wu and Knott (2006). They argue that entrepreneurs are risk-averse with respect to natural risks (in their case demand uncertainty) while they are seemingly risk-seeking, or overconfident, with respect to ability uncertainty.

[14] We consider a low investment to be any amount equal to five tokens or fewer.

The outside option in the *Coin Flip* treatment could for example represent a situation where a currently unemployed individual decides whether to try to join the labor pool, which is subject to natural risk in that the individual may land either a good or a bad job. Our findings suggest that when the outside option is sufficiently risky, individuals will flock into self-employment, and some of them will choose a business strategy which will allow them only a very modest payoff but at a low risk.

The next treatment examines a more extreme version of this situation. Here, employment ceases to be an option at all. Instead, individuals are required to pursue entrepreneurship but can control the stakes of the venture.

3.5 Introducing strategic risk into the outside option: The *Dual Market* treatment

In the *Dual Market* treatment the outside option ("option A") is itself a strategic situation requiring investments to secure a winner take all prize. The post-entry decisions from selecting this option are identical to those under the inside option. The only difference is that the winning entrepreneur is rewarded with 200 points under option A compared with 50 points under option B, as in the *Winner-Take-All* and the *Coin Flip* treatments. The expected payoff from the outside option now contains both strategic and natural risk.

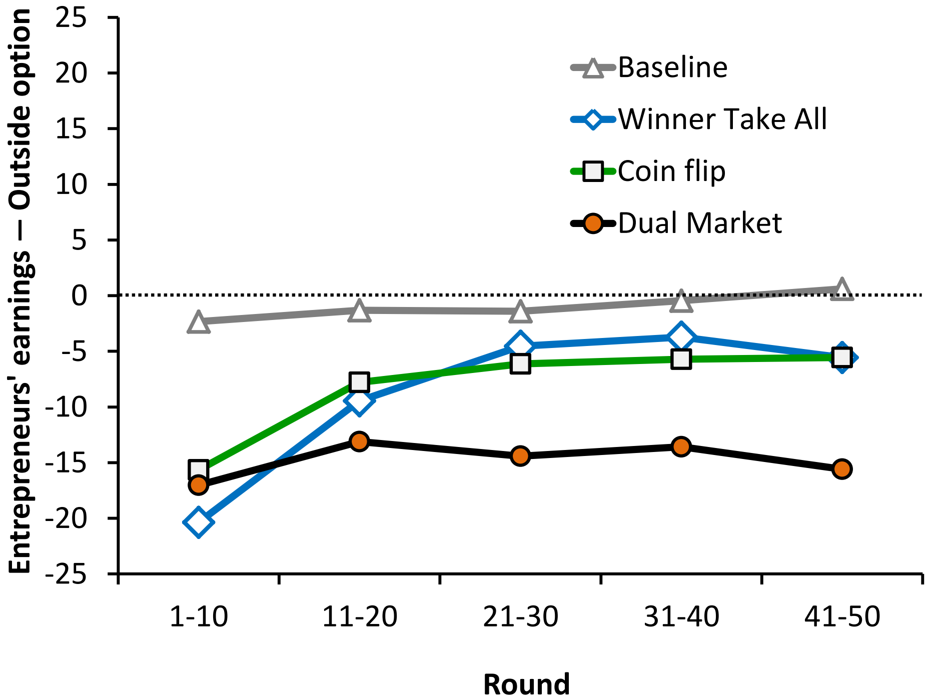
Assuming equilibrium investments, payoffs will be equalized when two players compete for the small prize while the remaining four players compete for the large reward. In this case, the expected payoff from the inside option is the same as in the other treatments. Thus, the standard equilibrium predictions under the assumption of risk neutrality are identical to those in the other treatments—the same number of players select the inside option, make the same investments, and enjoy the same expected return as in *Winner-Take-All, Coin Flip, Shares* and *Baseline*.

Figure 7 plots the payoff differential between the two markets over the course of the experiment. For reference, we include the payoff differentials from the other treatments as well. The figure is striking in two regards. First, the payoff differentials are extremely pronounced—selecting the inside option produces substantially lower returns than choosing the outside option. Second, experience does not produce convergence over time. Even in the last 10 rounds of the experiment, the null hypothesis of payoff equalization is strongly rejected (p-value = 0.008).

Returning to Figure 2, we see that, although in the early rounds of the experiment entry into the 50-point prize market appears to be somewhat lower than in the *Winner-Take-All* treatment, entry rates in *Dual Market* increase and by the end are very similar to those in the *Winner-Take-All* treatment.[15] Thus, as in *Winner-Take-All*, there is too much entry into the market with the 50-point reward relative to the equilibrium prediction. The flipside here, of course, is that the number of entrepreneurs in the 200-point prize contest is *lower* than predicted.

[15] In fact, the median and modal number of entrants is three in rounds 41-50 as compared to two in the *Winner-Take-All* treatment. However, there is no significant difference in the mean number of entrants. Also, the increase in entry in the *Dual Market* treatment is not statistically significant.

Figure 7. Payoff differentials in the *Dual Market* treatment



As Table 2 shows, investment is initially more modest in the *Dual Market* treatment (small prize) compared to *Winner-Take-All.* Over the course of the experiment, however, these investments move closer together and a test does not indicate a statistically significant difference at conventional levels.

Since both entry and investment are similar to *Winner-Take-All*, what accounts for the much more pronounced payoff differences in the *Dual Market* treatment? The answer turns on entrepreneurial behavior in the market with the larger prize. Normalized investments here are substantially lower than in any of the other treatments. Recall the breakeven level of investment against a fixed outside option, −10. Relative to this benchmark, we now observe significant *underinvestment*, unlike in any of the preceding treatments. Also, normalized investments in the large-prize market are significantly lower than in the small-prize market. We reject the null hypothesis of no difference (Fisher-Pitman test, $p = 0.008$).

Thus, entrepreneurs pursuing the large prize market enjoy substantial positive returns. Moreover, these returns are not competed away as subjects gain experience. Over the last 10 rounds of the experiment, entrepreneurs entering this market earned about 20.8 points. Of course, to capture these returns, individuals had to be willing to expose themselves to substantial risk. The absolute investments required to compete are larger than in the market with the smaller reward, and the outcomes more uncertain as a greater number of entrepreneurs compete.

The results are suggestive of the difference in returns to high versus low stakes entrepreneurship activities. While realtors and restauranteurs earn little from their entrepreneurship efforts (small business owners earn about 35% less than outside option (Hamilton, 2000), their downside exposure is also limited. For Silicon Valley startups however, the downside is considerably greater; however the rewards from this activity more than compensate. Cochrane (2005) analyzes the risk and return of venture capital investments and finds arithmetic alphas, a risk-adjusted measure of the return on investment, of 462% on average. Even controlling for selection bias (valuations are typically observed when a firm goes public, receives new financing or is acquired) his estimate of the arithmetic alpha still looms large at 32%. One could, perhaps, argue that there is a shortage of individuals with good ideas for startups and hence the rewards to this activity will not be competed away; however, the plethora of entrepreneurship activity during the dot-com bubble casts some doubt that this scarcity provides an effective barrier to entry.

4. Who becomes an entrepreneur?

We previously saw that the types of risk associated with the inside and outside options affect the prevalence of entrepreneurship as well as the investment made in success. To help understand these patterns, it seems important to identify key characteristics (if they exist) that determine who chooses the entrepreneurial path.

But even this question is premature since it presupposes that individuals sort themselves into entrepreneurial and non-entrepreneurial types. Our experiment offers an ideal setting for examining the degree to which individuals sort themselves into a particular path as they gain experience as well as the degree to which the types of risk faced by individuals influence sorting. To examine this, Table 3 displays Gini coefficients of entrepreneurship—the fraction of entry decisions accounted for by each of the subjects. As with a standard Gini coefficient, a value equal to zero indicates equality—all subjects are equally likely to pursue each path. A coefficient equal to one denotes the opposite extreme—subjects always choose a single path to the exclusion of the other. The three columns of the table show how this measure of specialization varies over the course of the experiment.

As the table shows, experience tends to lead subjects to more defined roles. In every treatment, the Gini coefficient associated with the first 10 rounds of the experiment is lower than for the last 10 rounds.[16] This suggests that, at least initially, subjects experiment with different roles before determining the one that is most suitable. However, even with experience, one does not see complete specialization. Subjects continue to switch roles, to some extent, and this varies with the treatment.

Table 3: Gini Coefficients[17]

Treatment	All	1-10	41-50
Baseline	.61	.51	.83
Shares	.61	.54	.81
Winner-Take-All	.52	.51	.66
Coin Flip	.42	.44	.49
Dual Market	.48	.47	.63

[16] Formally, a permutation test reveals that the difference in Gini coefficients between the first and last 10 rounds of the experiment are all significant at the 5% level save for *Coin Flip*, where there is no significant difference.
[17] While the Gini coefficients for the *Coin Flip* treatment are reported in terms of entry rather than entrepreneurship decisions, the quantitative values for this treatment are unchanged if we use the entrepreneurship instead of entry.

For experienced subjects, one can roughly group specialization into three tiers. Treatments where natural risk is absent (*Baseline* and *Shares*) have the highest level of specialization. The *Dual Market* and *Winner-Take-All* treatments represent an intermediate level of specialization while the *Coin Flip* treatment displays the lowest level of sorting. Formal statistical tests are supportive of this division as well. Treating each group as the unit of observation and performing a permutation test for rounds 41-50 of each treatment reveals that *Baseline* and *Shares* are statistically indistinguishable while both are different from *Winner-Take-All* and *Dual Market* at the 10% level. Similarly *Dual Market* and *Winner-Take-All* are statistically indistinguishable but *Coin Flip* differs from *Winner-Take-All* at the 10% significance level.

Taken together, Table 3 suggests that the presence of natural risk substantially reduces sorting. One mechanism by which this might occur is through feedback with good or bad luck in the market. For instance, an entrepreneur who has the good fortune of winning the market might choose to remain on this path while this same entrepreneur who experiences bad luck might opt to leave. Departures by these unlucky individuals then represent openings for previous non-entrepreneurs to enter given the apparently reduced competition in the market. That is, if subjects respond strongly to luck, then this offers a mechanism whereby one would see "churn" in the choice of entrepreneurship even for experienced subjects.

Despite the fact that natural risk reduces specialization, the Gini coefficients in Table 3 still suggest a fairly high degree of specialization. With experience, subjects are taking on more specialized roles though there is some degree of malleability. This suggests that it is fruitful to examine the key drivers of entrepreneurship. The extant literature on the topic highlights a number of forces that lead individuals to opt for this path.

One such force is skill. Individuals displaying a high degree of skill at the particular task are more likely to become entrepreneurs in that task so as to recoup a larger fraction of the returns from that effort. For example, Nguyen-Chyung (2011) shows that realtors who are more successful in making sales are more likely to pursue entrepreneurship than those that are less successful. To capture the notion of skill in our study, we calculate the expected payoffs from entrepreneurship over the first half of the experiment for each individual. The use of expectations removes the luck element from decisions. This provides us with a measure of the skill of each individual.

Table 4 reports the results of a probit analysis where we regress entry on various predictors of entrepreneurship for each treatment. In the column labeled "skill" we regress over the last half of the experiment (since we used the data from the first half of the experiment to construct the skill measure). The remaining columns use data from all rounds. To account for the non-independence of choices by the same subject over time, we cluster standard errors by subject. Finally, to account for learning, we include a linear trend term. The coefficients are reported in terms of marginal changes rather than as the raw output of the probit.

Table 4: Skill, Luck and Selection into Entrepreneurship

Treatment	Skill	Luck	Numerate	Business/Econ	Female
Baseline	.136***	---	.17**	.20**	−.05
Shares	.019**	---	.18**	.10	.02
Winner-Take-All	.006*	.005***	−.11	−.18**	.07
Coin Flip	.005	.003***	.06	.03	−.05
Dual Market	.004	.002**	−.13**	−.14*	−.05

The first column in Table 4 examines how skill impacts entrepreneurship. Consistent with the extant literature, greater skill at the task does indeed predict a greater likelihood of pursuing entrepreneurship. The regression coefficients can be interpreted as the percentage increase in the probability of becoming an entrepreneur given a one unit increase in skill. To put this increase in skill in perspective, the interquartile range of the skill measure is about 10 units. Thus, a subject at the top of this range is about 136% more likely to enter in the Baseline treatment compared to a subject at the bottom of the range.

As Table 4 reveals, the addition of both types of risk leads to a reduction in the influence of skill on the path chosen. Comparing the coefficients in Baseline versus Shares, one sees that the introduction of strategic risk leads to a sevenfold drop in the influence of skill on entry. Comparing Shares to *Winner-Take-All* shows that the further addition of natural risk on top of strategic risk reduces the influence of skill by a further threefold. Nonetheless, skill still matters—a highly skilled (75^{th} percentile) subject is about 6% more likely to enter compared to a less skilled (25^{th} percentile) subject.

The addition of various kinds of risk in the outside option renders the skill measure insignificant. For the case of the *Dual Market*, the measure is inherently problematic. Perhaps skilled individuals should try their luck at the market with the larger reward. Moreover, the measure only accounts for performance in the small contest, but clearly a correct measure of skill is one that takes account of overall investment skill. Correcting for this by measuring overall skill yields a coefficient of -0.01***. Despite the switch in the sign of the coefficient, skill plays the expected role—more skilled subjects are more likely to pursue the market with the larger reward by about 1% per unit of skill.

Earlier, we speculated that luck might play an important role in explaining the lower levels of specialization we observe when natural risk is present. The second column of Table 4 investigates this possibility. The variable "luck" measures the difference between the realized payoff and the expected payoff.[18] Since luck is absent from the Baseline and Shares treatments, we do not report any coefficients. As the table shows, luck plays an important role in determining the choice of paths. Since there is a 50 point swing between being lucky and unlucky in the market, the coefficient on the *Winner-Take-All* treatment shows that lucky entrepreneurs are about 25% more likely to enter in the next period compared to unlucky competitors.

One might expect to see the same effect based on the luck of the coin for subjects who opted not to enter in the *Coin Flip* treatment. If we construct a similar measure of luck, the resulting

[18] Obviously, we only have such a measure for the subset of the data where a given subject pursued entrepreneurship in the previous round.

regression coefficient 0.001 indicating slight persistence based on luck; however the coefficient does not come close to statistical significance. The difference in the reaction to luck in the market versus the coin flip is suggestive of the familiar “illusion of control” biases observed in the psychology literature. In entrepreneurship, lucky or unlucky outcomes are attributed to skill and require an appropriate reevaluation of one’s strategy whereas in the coin flip, subjects correctly attribute luck as being purely a force of nature, hence requiring no such reevaluation.

A person’s background and training are also thought to give rise to choosing the path to entrepreneurship. Indeed, many business schools offer courses or even whole programs devoted to entrepreneurship on the theory that this will both lead people to choose this path and help them to be more effective at it. In our experiment, investment skill is critical to the success or failure of entrepreneurs. Obviously, familiarity with probabilities as well as comfort in working with numbers would seem to be pre-requisites for someone to choose to pursue entrepreneurship.

To investigate this possibility, we collected demographic data about the major field of studies of each of our subjects. We then divided these into “numerate” fields, areas of study where mathematics or statistics play an important role, and non-numerate fields. For example, we coded Physics as a numerate field while we coded English as non-numerate. We constructed a similar measure for whether a subject had business or economics training. Appendix B contains the complete list of major fields of subjects in our study as well as how we coded them with respect to these measures.

When natural risk is absent, our measures go in the expected direction—individuals in numerate majors and individuals with business/economics training are more likely to choose the entrepreneurship path. However, the introduction of natural risk substantially changes the findings. In the *Dual Market*, numerate and business/econ trained are more likely to choose the high stakes contest, which also turns out to be more profitable. For *Winner-Take-All*, such individuals are *less* likely to pursue entrepreneurship. Since entrepreneurship produces such poor returns, perhaps the main benefit of this training is simply recognizing this path for the poor choice that it turns out to be. For the *Coin Flip* treatment, there is, essentially, no effect.

Risk preferences are also thought to play a key role in the decision to become an entrepreneur. In particular, a number of studies (e.g. Niederle and Vesterlund (2007)) have shown that women, in particular, shy away from competitive paths. When faced with a choice between piece rate compensation and compensation based on relative performance, Niederle and Vesterlund found that women overwhelmingly preferred the former even when they were equally skilled with men. They argue that, since many studies have shown women to be more risk averse than men, this choice is a manifestation of risk preferences. In Column 6 of Table 4, we study entry choices by gender. As the table shows, we find no significant differences in entry across genders. Moreover, in *Shares*, *Winner-Take-All*, and *Dual Market*, the coefficient estimates suggest that women choose the riskier option. Indeed, simply looking at raw statistics of choices, women are more likely than men to select the risky option overall. Moreover, unlike the previous real effort studies, women are significantly worse at investing than men. If we compare payoffs from entrants by gender, we find that women score about 2.75 points lower than men, a difference that is significant at the 1% level. In short, we find little evidence that women are inhibited from pursuing entrepreneurship despite being objectively worse at it.

5. Post hoc rationalizations

The equilibrium notion that free entry will equalize payoffs between the inside and outside options is a powerful tool of economic analysis. Entry experiments, where both strategic and natural risk is absent, mainly confirm the force of this reasoning. Our findings, however, cast considerable doubt on the force of payoff equalization in more complex settings. Payoffs continue to equalize with the addition of strategic risk, but the combination of strategic and natural risk leads to large and persistent gaps between the average payoffs from entrepreneurship versus the outside option.

One obvious reason why the expected payoffs from the two activities might differ is risk preferences. If subjects are generally risk averse then they should demand a premium for exposing themselves to the luck element of entrepreneurship. However, this is not at all what we see in the *Winner-Take-All* treatment—relative to the fixed outside option the return from entrepreneurship carries a *negative* risk premium. To explain this pattern using risk preferences, we are forced to conclude that entrants are risk loving. Moreover, since between one-third and one-half of subjects choose the entrepreneurship path in a given round of the game, this then implies that one-third to one-half of our subject pool must be *risk loving*.

How reasonable is this conclusion? Certainly, such a large fraction of risk-loving individuals is inconsistent with the extant experimental literature measuring risk preferences. For instance, in the seminal Holt and Laury (2002) paper on the topic, they found that fewer than 10% of subjects can be characterized as risk loving to any degree. Replications of their work report similarly low levels of risk loving behavior. Indeed, our subjects are drawn from the same subject pool as those of Humphrey and Renner (2011), who conduct a Holt-Laury risk elicitation task and find that only 9 out of 134 subjects in their experiment (7%) can be classified as risk-loving.

The results of the *Coin Flip* treatment also run contrary to a risk preference explanation. The *Coin Flip* treatment was parameterized so that the risk of the outside option is similar to the risk of entrepreneurship. Recall that, to rationalize the results of the winner-take-all treatment, one needed to assume that about half the subjects are risk loving and half risk averse. In the *Coin Flip* treatment, the risk averters should switch from employment to entrepreneurship, where they can avoid risk by betting little or nothing. However, since about two-thirds of subjects chose entrepreneurship under this treatment, the marginal entrepreneur must be risk-loving. Moreover, since the risks of employment and entrepreneurship are similar, the returns must likewise be similar.[19] But instead we find that entrepreneurship produces significantly lower returns.

Similar considerations show that loss-aversion can explain only some of our findings. Morgan and Sisak (2012) show that loss aversion can rationalize some aspects of the data but cannot explain one of the most basic facts from the data—that subjects earn negative returns from entrepreneurship in the *Winner-Take-All* treatment. This stems from the fact that, in many respects, loss averse and risk averse behavior is similar in this setting; hence, loss-averse subjects require a premium to choose the entrepreneurship path.

[19] Indeed, the sample standard deviation is lower under entrepreneurship than under employment in the coin flip treatment. Thus, the marginal risk-loving entrepreneur must be compensated with a *higher* return for forgoing the risk from employment. This, however, is the opposite of what we observe.

An alternative explanation is that non-pecuniary preferences suppress the returns from entrepreneurship. For instance, subjects may simply enjoy making investments and seeing the wheel of fortune determine outcomes and be willing to pay a positive premium for this privilege. This explanation also has difficulties. First, one would think that, after so many iterations of the game, the excitement of the investment contest would wear off and payoffs would converge. Second, one would think that the coin flip activity offers a similar level of excitement to the investment game and therefore payoff differences would narrow in this treatment. In fact, we observe the opposite. Third, while it may be exciting to choose the entrepreneurship path, it is unclear why this excite should lead to overly aggressive investment behavior. Finally, and in our view most tellingly, this explanation fails to account for the findings of our *Dual Market* treatment. One would think that the market with the large prize would be even more exciting than the market with the smaller prize in *Dual Market*. Thus, under this hypothesis, the large prize market should produce lower expected returns, which is again the opposite of what we observe.

Perhaps subjects are motivated by status. Perhaps winning the contest confers a status advantage on subjects that makes them willing to sacrifice pecuniary returns. Again, this explanation founders given the results in the *Dual Market*. Clearly, the greatest status gains are to be had in the more popular contest (i.e. the market with the large prize) and hence subjects should enter and compete most aggressively here. However, we find that the opposite on both counts. Entry is consistent with Nash equilibrium models where subjects pay no attention to status. Worse yet, investment is significantly *below* the levels predicted by a model where status is completely absent.

Thus, we are left with a puzzle. Standard (and even not so standard) amendments to the usual model of rational agents driven purely by pecuniary considerations are simply incapable of rationalizing the constellation of findings in our data. Determining an appropriate model is obviously an important topic for future research.

6. Discussion and conclusions

The decision to become an entrepreneur is fraught with peril. One risk that entrepreneurs face, what we term strategic risk, stems from the interactive nature of payoffs—an entrepreneur's fate is not solely under her control, but rather depends on the strategy decisions of rivals in the same market. Natural risk also plays a key role. Despite her best efforts, an entrepreneur's success or failure is determined by the whims of fate. Random fluctuations in tastes, fads, and fashions are often the difference between a winning venture and a losing one.

Using laboratory experiments, we isolate these two types of risk and examine how they affect the decision to become an entrepreneur as well as the business strategy undertaken post-entry. Our setting also allows us to observe the "life cycle" of entrepreneurism—how choices and strategies evolve as an entrepreneur gains experience in the market.

In settings primarily characterized by strategic risk, standard economic theory performs well in predicting the entry and investment decisions of entrepreneurs. While payoffs from entrepreneurship are initially depressed compared to the returns from a safe outside option, with experience, individuals sort themselves into entrepreneur and non-entrepreneur groups. Since there are no barriers to switching between groups, it is hardly surprising that the expected payoffs between the two groups approximately equalize.

Adding natural risk to the setting changes matters considerably. Individuals are now slightly more inclined to pursue the entrepreneurship path and much more inclined to invest aggressively post-entry. As a consequence, the returns from entrepreneurship badly lag those from an outside option, regardless of whether it is safe or risky. Even with experience, these returns differences persist. Our experiment thus nicely complements the empirical findings of Hamilton (2000), showing that the pecuniary returns to entrepreneurship are negative. While he argues for the importance of non-pecuniary benefits, we show that even in the absence of these, their findings carry importance. It is left to future research to "rationalize" the reasons for these payoff differentials.

We do, however, observe an important exception to this pattern: when subjects are required to pursue entrepreneurship and can only control the stakes of the game in which they are participating, we find little appetite for risk. Relative to standard theory, too few subjects opt for the high stakes path and those that do invest less aggressively than theory predicts. In this setting, the payoff differential between the two entrepreneurship paths is large and persistent.

Perhaps equally important is the fact that natural risk reduces the sorting of individuals into entrepreneurs and non-entrepreneurs. In effect, entrepreneurship becomes a revolving door. Those who enter and are unlucky leave only to be replaced by individuals previously on the sidelines now willing to take a chance on being an entrepreneur. Lucky entrepreneurs, on the other hand, persist in the market, and seem to confuse luck for skill in this setting. These results are consistent with the empirical findings of Mazzeo (2004) who notes that, in riskier settings, there is less specialization between the entrepreneur and non-entrepreneur classes.

Entrepreneurship is widely viewed as a key national growth driver and, indeed, many countries have policies put into place to reward this activity. Our findings shed light on some aspects of these policies. First, for small stakes entrepreneurship, the problem may be one of too much rather than too few. The combination of too little specialization, too much entry, and too aggressive a level of investment may well prove socially wasteful rather than socially beneficial. In large stakes settings, the opposite problem arises and here policy can clearly help. In effect, our subjects are somewhat capital constrained in entering markets with large prizes. They have no ability to hedge or offset their risk and, to be successful, they need to wager a significant portion of their endowment. Our results suggest that initiatives designed to create liquidity and offset some risk could prove beneficial.

Of course, there is a vast gulf between the much simplified entrepreneurial settings we study in the lab and real-world entrepreneurship. Nonetheless, laboratory settings are crucial in understanding reactions to different sources of risk and benchmarking relative to the predictions of economic models. Thus, we view our findings as informative, but hardly the last word, on strategic and natural risk and their effect on entrepreneurship.

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Appendix A: Instructions for the Experiment

Welcome! You are about to take part in an experiment in the economics of decision making. You will be paid in private and in cash at the end of the experiment. The amount you earn will depend on your decisions, so please follow the instructions carefully.

It is important that you do not talk to any of the other participants until the experiment is over. If you have a question at any time, raise your hand and someone will come to your desk to answer it.

The experiment will consist of fifty rounds. In each round you will be matched with the same five other participants, randomly selected from the people in this room. Together, the six of you form a group. Note that you will not learn who the other members of your group are, neither during nor after today's session.

Each round is identical. At the beginning of the round you will be given an initial point balance of 100 points. You will then have up to 15 seconds to decide between option A and option B. If, at the end of that time, you have not made a choice, then the computer will make a choice for you by selecting randomly between the two options. During the 15 seconds, your computer screen will keep you informed of how many group members have chosen each of the options so far, as well as the time remaining for you to make a choice. At the end of the 15 seconds the computer will display your choice and the number of group members choosing each option. Your final point earnings for the round will depend on your choice and the choices of other group members as described below.

At the end of the experiment one of the fifty rounds will be selected at random. Your earnings from the experiment will depend on your final point earnings in this randomly selected round. The final point earnings will be converted into cash at a rate of 10p per point.

Option A

[**Baseline, Shares, Winner-Take-All:** If you select option A, 10 points will be added to your point balance. Your final point earnings for the round will be 110 points.]

[**Coin Flip:** If you select option A, your final point earnings for the round will depend on the outcome of a computerized coin flip. The coin is equally likely to come up heads or tails. If the coin comes up heads 35 points will be added to your initial point balance and your final point earnings for the round will be 135 points; if the coin comes up tails 15 points will be subtracted from your initial point balance and your final point earnings for the round will be 85 points.]

[**Dual Market:** If you select option A you will have a chance to win a prize of 200 points.

First, if you are the only group member to select option A, you will automatically win the prize, and 200 points will be added to your initial point balance. Your final point earnings for the round will be 300 points.

Second, if more than one group member selects option A there will be a contest among these group members to determine who wins the prize. In this contest the players first decide how many "contest tokens" to buy. Each contest token you buy reduces your point balance by 1 point. You can purchase up to 100 of these tokens. Everybody will be making this decision at the same time, so you will not know how many contest tokens the other players have bought when you make your choice. You will have 30 seconds to make a decision about how many contest tokens to buy. If you do not make a decision within this time limit the computer will make a choice for you by selecting zero tokens.

If nobody buys any tokens, nobody wins the prize. Otherwise, your chances of winning the prize will depend on how many contest tokens you buy and how many contest tokens the other players buy. This works as follows:

A computerized lottery wheel will be divided into shares with different colors. One share belongs to you and the other shares belong to each of the other players (a different color for each player). The size of your share on the lottery wheel is an exact representation of the number of contest tokens you bought relative to all contest tokens purchased. For instance, if you own just as many contest tokens as all the other players put together, your share will make up 50% of the lottery wheel. In another example, suppose that there are four players (including you) and that each of you owns the same number of contest tokens: in that case your share will make up 25% of the lottery wheel.

Once the shares of the lottery wheel have been determined, the wheel will start to rotate and after a short while it will stop at random. Just above the lottery wheel there is an indicator at the 12 o'clock position. The indicator will point at one of the shares, and the player owning that share will win the prize. Thus, your chances of winning the prize increase with the number of contest tokens you buy. Conversely, the more contest tokens the other players buy, the lower your chances of receiving the prize.

If you win the prize 200 points will be added to your point balance. Your final point earnings for the round will be (100 – the number of contest tokens you bought + 200) points.

If another player wins the prize zero points will be added to your point balance. Your final point earnings for the round will be (100 – the number of contest tokens you bought) points.]

Option B

[**Baseline:** If you select option B you will receive some additional points depending on how many players choose option B.

If you are the only group member to select option B 50 points will be added to your initial point balance. Your final point earnings for the round will be 150 points.

If you and one other group member selects option B 13 points will be added to your initial point balance. Your final point earnings for the round will be 113 points

If you and two other group members select option B 6 points will be added to your initial point balance. Your final point earnings for the round will be 106 points

If you and three other group members select option B 3 points will be added to your initial point balance. Your final point earnings for the round will be 103 points

If you and four other group member selects option B 2 points will be added to your initial point balance. Your final point earnings for the round will be 102 points

If you and five other group member selects option B 1 point will be added to your initial point balance. Your final point earnings for the round will be 101 points]

[**Shares:** If you select option B you can receive a share of a prize of 50 points.

First, if you are the only group member to select option B, you will automatically receive all of the prize, and 50 points will be added to your initial point balance. Your final point earnings for the round will be 150 points.

Second, if more than one group member selects option B there will be a contest among these group members to determine how the prize is shared. In this contest the players first decide how many "contest tokens" to buy. Each contest token you buy reduces your point balance by 1 point. You can purchase up to 100 of these tokens. Everybody will be making this decision at the same time, so you will not know how many contest tokens the other players have bought when you make your choice. You will have 30 seconds to make a decision about how many contest tokens to buy. If you do not make a decision within this time limit the computer will make a choice for you by selecting zero tokens.

If nobody buys any tokens, nobody receives any of the prize. Otherwise, your share of the prize will equal your share of all tokens bought times 50 points, rounded to the nearest point.

For example, if all players (including you) bought a total of 100 tokens and you bought 25 of these your share of all tokens bought is 25%. Your share of the prize is 25% of 50 points or 12.5 points, which is rounded to 13 points.

Thus, your share of the prize increases with the number of contest tokens you buy. Conversely, the more contest tokens the other players buy, the lower will be your share of the prize.

Your share of the prize will be added to your point balance. Your final point earnings for the round will be (100 – the number of contest tokens you bought + your share of the prize) points.]

[**Winner-Take-All, Coin Flip:** If you select option B you will have a chance to win a prize of 50 points.

First, if you are the only group member to select option B, you will automatically win the prize, and 50 points will be added to your initial point balance. Your final point earnings for the round will be 150 points.

Second, if more than one group member selects option B there will be a contest among these group members to determine who wins the prize. In this contest the players first decide how many "contest tokens" to buy. Each contest token you buy reduces your point balance by 1 point. You can purchase up to 100 of these tokens. Everybody will be making this decision at the same time, so you will not know how many contest tokens the other players have bought when you make your choice. You will have 30 seconds to make a decision about how many contest tokens to buy. If you do not make a decision within this time limit the computer will make a choice for you by selecting zero tokens.

If nobody buys any tokens, nobody wins the prize. Otherwise, your chances of winning the prize will depend on how many contest tokens you buy and how many contest tokens the other players buy. This works as follows:

A computerized lottery wheel will be divided into shares with different colors. One share belongs to you and the other shares belong to each of the other players (a different color for each player). The size of your share on the lottery wheel is an exact representation of the number of contest tokens you bought relative to all contest tokens purchased. For instance, if you own just as many contest tokens as all the other players put together, your share will make up 50% of the lottery wheel. In another example, suppose that there are four players (including you) and that each of you owns the same number of contest tokens: in that case your share will make up 25% of the lottery wheel.

Once the shares of the lottery wheel have been determined, the wheel will start to rotate and after a short while it will stop at random. Just above the lottery wheel there is an indicator at the 12 o'clock position. The indicator will point at one of the shares, and the player owning that share will win the prize. Thus, your chances of winning the prize increase with the number of contest tokens you buy. Conversely, the more contest tokens the other players buy, the lower your chances of receiving the prize.

If you win the prize 50 points will be added to your point balance. Your final point earnings for the round will be (100 – the number of contest tokens you bought + 50) points.

If another player wins the prize zero points will be added to your point balance. Your final point earnings for the round will be (100 – the number of contest tokens you bought) points.]

[**Dual Market:** If you select option B you will have a chance to win a prize of 50 points.

First, if you are the only group member to select option B, you will automatically win the prize, and 50 points will be added to your point balance. Your final point earnings for the round will be 150 points.

Second, if more than one group member selects option B there will be a contest to determine who wins the prize. This contest works in the same way as that described for option A, except that the prize is 50 points.]

Now, please look at your computer screen and begin making your decisions. If you have a question at any time please raise your hand and a monitor will come to your desk to answer it.

Appendix B: Categorization of Study Fields for Business/Economics and Numerate

Numerate:
Accounting, Architectural Engineering, Architectural Studies, Architecture, Biochemistry, Biochemistry and Biological Chemistry, Biology, Bioscience, Biotechnology, Business, Chemical Engineering, Chemistry, Civil Engineering, Computer Science, Economics, Electrical Engineering, Electronic Engineering, Engineering, Environmental Engineering, Finance, Genetics, Industrial Economics, Information Technology, International Economics, Life Sciences, Management, Mathematics, Mechanical Engineering, Medicine, Molecular Diagnostics, Neuroscience, Pharmacy, Physics, Risk Management

Business/Economics:
Accounting, Business, Business Management, Business Studies, Economics, Finance, Industrial Economics, International Economics, Management, Mathematics & Economics, Risk Management